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NOAA's Science Supports Shellfish Aquaculture

NOAA conducts critical research to better understand threats to the production and marketability of shellfish, including ocean acidification, habitat degradation, toxins, and pathogens.

NOAA is committed to providing relevant, robust science to support shellfish aquaculture in Washington State and beyond.

In the Pacific Northwest, NOAA's science has substantially increased our understanding and ability to monitor and mitigate the various threats to the production and marketability of West Coast's valuable shellfish. NOAA scientists are developing a sophisticated ocean monitoring system that provides the real-time information shellfish growers need to strategically manage hatchery operations, and are continuing laboratory studies of the biological effects of ocean acidification on cultured species. NOAA is also restoring native oyster habitat and developing powerful, predictive tools to forecast dangerous algal blooms or pathogens that can contaminate shellfish in Puget Sound.

Shown right: NOAA plans to expand the global network for monitoring ocean acidification by adding carbon, pH, and other biogeochemical sensors to open ocean and coastal moorings. Photograph by John Payne, Pacific Ocean Shelf Tracking Project.

Ocean Acidification Data Benefits West Coast Shellfish Industry

Ocean acidification is considered by many to be one of the biggest oceanographic challenges in the coming century. As a research priority at NOAA, agency researchers are helping to advance the science and manage the consequences of ocean acidification on our nation's marine resources, shellfish hatchery operations, and the local economy of coastal communities.

Characterizing the Threat

NOAA scientists were among the first to measure the changes in oceanic acidity. Researchers also detected that the marine waters along the Pacific Northwest coast are naturally more acidic than other areas, and that upwelling along the West Coast made the near-shore coastal region—where more shellfish is raised—particularly vulnerable to the corrosive effects of ocean acidification. NOAA recently led interagency and regional efforts to collect real-time data from its network of offshore buoys and other advanced ocean observing systems, which act as an early warning system for shellfish hatcheries. This sophisticated system can detect the approach of cold, acidified seawater one to two days before it arrives in the particularly vulnerable coastal waters where shellfish larvae are cultivated. These data can help shellfish hatchery managers improve their operations by scheduling shellfish production when water quality is good, and avoid wasting valuable energy and other resources when water quality is poor.

Learn more:
www.psp.wa.gov/shellfish.php
and
http://aquaculture.noaa.gov

An Ocean Time Machine

NOAA also runs a state-of-the-art ocean acidification laboratory, an ocean "time machine", where scientists can observe the biological impacts on Pacific Northwest marine life under experimental conditions that mimic pre-industrial, current, and future ocean CO^2 levels. Scientists are currently conducting these studies on larval geoduck, Pacific oyster, Olympia oyster, pinto abalone, krill, copepods, Dungeness crabs, herring, and rockfish. Scientists are using the information from these experiments to model ecosystems and identify how individual species change as a result of acidification, which may affect the entire marine food web.

Shown above: A shell placed in seawater with increased acidity will slowly dissolve. Oyster larvae are also at risk in acidic water, sometimes failing to survive past the egg stage.

NOAA's Ocean Acidification Research & Shellfish Aquaculture

NOAA's ocean acidification research and monitoring efforts have directly benefitted the $110 million West Coast shellfish industry. Five years ago, the production at some oyster hatcheries in the Pacific Northwest began declining at an alarming rate as developing larvae failed to attach to their shells, a problem that threatened the livelihoods of shellfish growers across Oregon and Washington. By 2008, the oyster harvest at Whiskey Creek, a major Oregon supplier of the majority of West Coast oyster farmers, had plummeted by 80%. NOAA's investment in a seawater monitoring program provided real-time information of ocean conditions that Pacific oysters can and cannot tolerate, enabling hatchery managers to quickly adapt their operations accordingly (for example, by shutting off the intake to their hatcheries as acidity increases) to optimize larvae production. Although the effects of ocean acidification were less extreme in 2010 and 2011, these efforts ultimately helped bring the industry back from the verge of collapse.

What is Ocean Acidification?

The world's oceans absorb about one-third of human-generated carbon dioxide (CO^2) from the atmosphere every day. Based on decades of ocean observations, NOAA scientist Dr. Dick Feely discovered that the increasing levels of atmospheric CO^2 are causing fundamental changes in seawater chemistry through a process called ocean acidification. When mixed with seawater, CO^2 forms carbonic acid and increases the ocean's acidity and reduces the amount calcium carbonate, depleting our oceans of the vital nutrient that some marine species rely on to form their shells or skeletons. Ocean acidification is an emerging global problem with potential ripple effects on both marine life and humans, particularly since shell-producing organisms key components of marine food webs and some are an important sources of human food. Ocean acidification also threatens the prosperity and health of the $110 million shellfish industry, with additional indirect losses to the finfish industry because of potential declines in fish prey species.

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Native Oyster Restoration & Habitat Improvement

Restored oyster beds can dramatically improve complex nearshore habitat, increase natural filtration, and enhance larval production. Good oyster habitat will also attract and benefit other marine species, including invertebrates and salmon. NOAA's contribution to native oyster habitat restoration in Puget Sound will ultimately help Tribes, shellfish growers, resource managers, and citizens regain the ecological and economic benefits from viable shellfish aquaculture.

Shown above: Restoration efforts in the Puget Sound are aimed at re-establishing dense beds of Olympia oysters to provide habitat structure, increase filtration and enhance biodiversity.

For over a decade, NOAA has contributed to the restoration of native Olympia oysters throughout the West Coast, resulting in over 50 acres of restored habitat. With increased urban and agricultural development, we face additional challenges from the continuing loss of upland and lowland habitat in Puget Sound. NOAA's collaborative efforts to rebuild Puget Sound Olympia oyster populations, currently at 4% of their historic levels, are part of an ambitious new project to restore native Olympia oysters and the habitat that sustains them, with the goal of restoring 100 acres of native oyster habitat in Puget Sound by the year 2020. Hatchery production of healthy oyster seed (oyster larvae attached to a shell) is a top research priority, as West Coast oyster growers have experienced significant oyster mortalities due to upwelling of acidic waters and a corresponding decrease in harvest rates since 2005. NOAA is working to create self-sustaining, genetically-diverse oyster beds through a novel breeding program to help these native populations be resilient to various threats.

Mussel Bioextraction Pilot Study to Improve Water Quality

Shown right: NOAA scientists monitor ribbed mussel feeding activities as part of a pilot study to improve water quality in Long Island Sound. Photograph by Larissa Graham, New York Sea Grant.

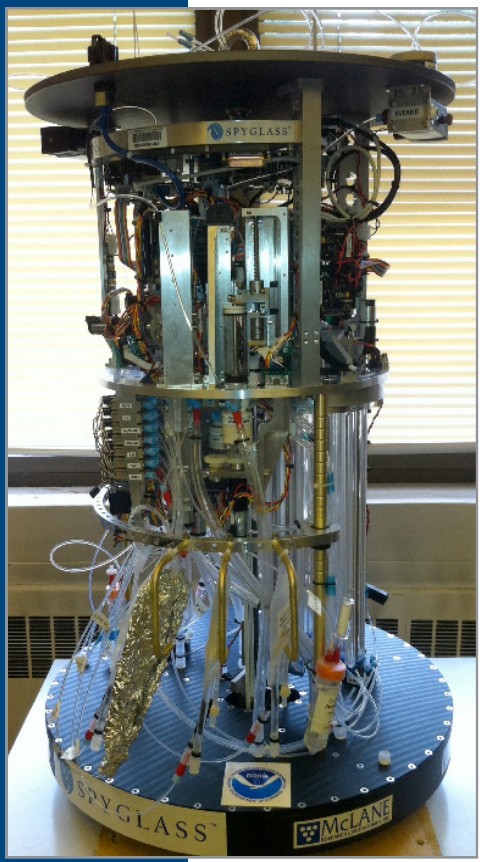
NOAA has a long history of productive molluscan aquaculture research that continues to benefit this growing industry. NOAA's Milford lab in Connecticut is conducting a pilot study to test how effectively ribbed mussels remove nitrogen and other excess nutrients from coastal waters of Long Island Sound in a process called "nutrient bioextraction". Information from this study will be used to evaluate the potential for mussel aquaculture to increase water filtration in an urban environment and also help characterize beneficial ecosystem services that would be provided by this approach, such as improvements in water quality, removal of bacteria, and assimilation of nutrients. The results of this pilot study can also be used to inform models of shellfish nutrient mitigation for Puget Sound, particularly in its oxygen-depleted "dead zones".

Science, Service, Stewardship

Developing an Early Warning System to Protect Shellfish from Toxins & Pathogens

Tracking Toxic Blooms & Pathogens with ESP

The Environmental Sample Processer (ESP) shown is an advanced biological sensing system that can conduct automated collection and analysis of water samples in its original or existing position. Using DNA-based technology, the ESP acts as an autonomous buoy that can remotely detect harmful algae and bacterial pathogens and send the results to shore in near-real time via radio or satellite. With additional research, the ESP can significantly enhance existing monitoring programs in Puget Sound by eliminating lengthy delays associated with traveling to collect a water sample and transporting it back to the laboratory for analysis. This technology, together with weather forecasts and existing monitoring networks, has the potential to enable NOAA and partners to forecast the risk of an outbreak of toxic blooms and pathogens a few days to a week in advance—the timescale that is most useful to shellfish growers and public health officials.



Currently, there are limited predictive tools available to forecast toxic algal blooms or pathogens that can contaminate shellfish in Puget Sound, significantly impact the West Coast shellfish industry through extensive beach closures, and adversely affect human health via seafood-borne illness.

NOAA scientists are turning the tide to provide advanced warning of potentially dangerous outbreaks of harmful algal blooms and pathogens such as *Vibrio parahaemolyticus.* By developing an integrated system that combines weather forecasts, an existing monitoring network for harmful algae in Puget Sound (known as Sound Toxins), and a novel biosensor instrument dubbed the ESP (Environmental Sample Processor), scientists will be able to help shellfish growers and public health officials better prepare for management decisions like beach closures and mitigate economic impacts.

Shown below: NOAA scientists are developing better tools to provide early and accurate warnings to the risks of a harmful algal bloom or bacterial outbreak affecting shellfish. Such forecasts can help managers protect the West Coast's valuable shellfish resources as well as human and ecosystem health. Photography by Bill Dewey, Taylor Shellfish Farms